Great Lakes Cladophora Research Initiative

Lake Ontario Sub-component: Nearshore Benthos Survey

A2. Table of Contents

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A4. Problem Definition/Background:

The 2012 revision of the 2012 Great Lakes Water Quality Agreement includes a commitment for the US and Canada to reconsider current nutrient targets for water concentrations and total basin loadings due to the recent apparent resurgence of nearshore eutrophication problems. Lake Ontario's western shoreline is listed on New York's 303D list of impaired waters due to excessive growth benthic algae. Computer modelling of nutrient transport and monitoring are underway to help evaluate possible management options to address these problems. However, there is little information on New York Lake Ontario specific conditions that influence and control the growth of benthic algae that could be used to develop and test cladophora growth models that could inform potential management options. Lake Ontario specific information on cladophora growth rates and response to nutrient, temperature and light energy is needed given lake-to-lake differences. Given the limitations of most of the large research vessels to safely operate in shallow waters, there is much less information on nearshore lake bottom conditions and factors that influence and control the growth of benthic algae (*Cladophora*).and invasive dreissenid mussel density and distribution.

The critical measurements required for model calibration are *Cladophora* production as a function of irradiance, temperature and tissue P content, and *Cladophora* loss to sloughing. In addition, dreissenid mussel P recycling as a function of temperature and food supply is required to calibrate the mussel sub-model. Model validation will require *in situ* measurements of *Cladophora* production, tissue P content, temperature, light, particulate P concentration,and dissolved P.

This survey, taken together with planned Canadian Lake Ontario work (Environment and Climate Change Canada & Ontario Ministry of the Environment and Climate Change), using the same standard operating procedures, will provide a consistent set of data to better understand factors controlling the growth of nuisance benthic algae. Sampling stations will be selected to provide information about the status and trends of water quality, dreissenid mussels and *Cladophora*, a nuisance benthic alga that has resurged despite phosphorus loading and concentration reductions over the past four decades. This work is supported by EPA's Great Lakes Restoration Initiative (GLRI) in support of the U.S. – Canada Great Lakes Water Quality Agreement. The USGS will be conducting the same surveys in the US waters of the other Great Lakes.

A5. Project/Task Description: U.S. EPA Region 2 & ERT divers will assist the USGS in collecting seasonal samples and information from three Lake Ontario nearshore transects. This work can be divided into 3 distinct tasks: characterizing nutrients in water and algae, collecting and analyzing algal and mussel biological samples and measurement of physical parameters that control algal growth. Transect locations were selected to reflect three different nutrient impact zones: 1) Niagara River plume impacts; 2) Genesee River plume impacts and 3) Algal growth in a relatively unimpacted area (Figure 1).

USGS divers will locate transect stations and deploy moored sensors in May 2018. EPA diver will sample these locations, upload sensor data, and maintain sensors in June, July and August 2018. USGS divers will return in Sept and October to complete the survey and retrieve the sensors. Diver teams will collect water quality, cladophora and mussel samples along each transect at depths of 3, 6, 10 and 18 meters. Table 1 summarizes samples to be collected and analyses to be performed. A suite of moored sensors will collect continuous data on a range of environmental conditions. Sample analyses, data analyses and report writing will be coordinated as part of the Great Lakes wide USGS Cladophora Research Initiative.

Figure 1. Location of 3 New York dive survey transects on Lake Ontario's south shore. Location of Canadian dive survey transects shown on north shore.

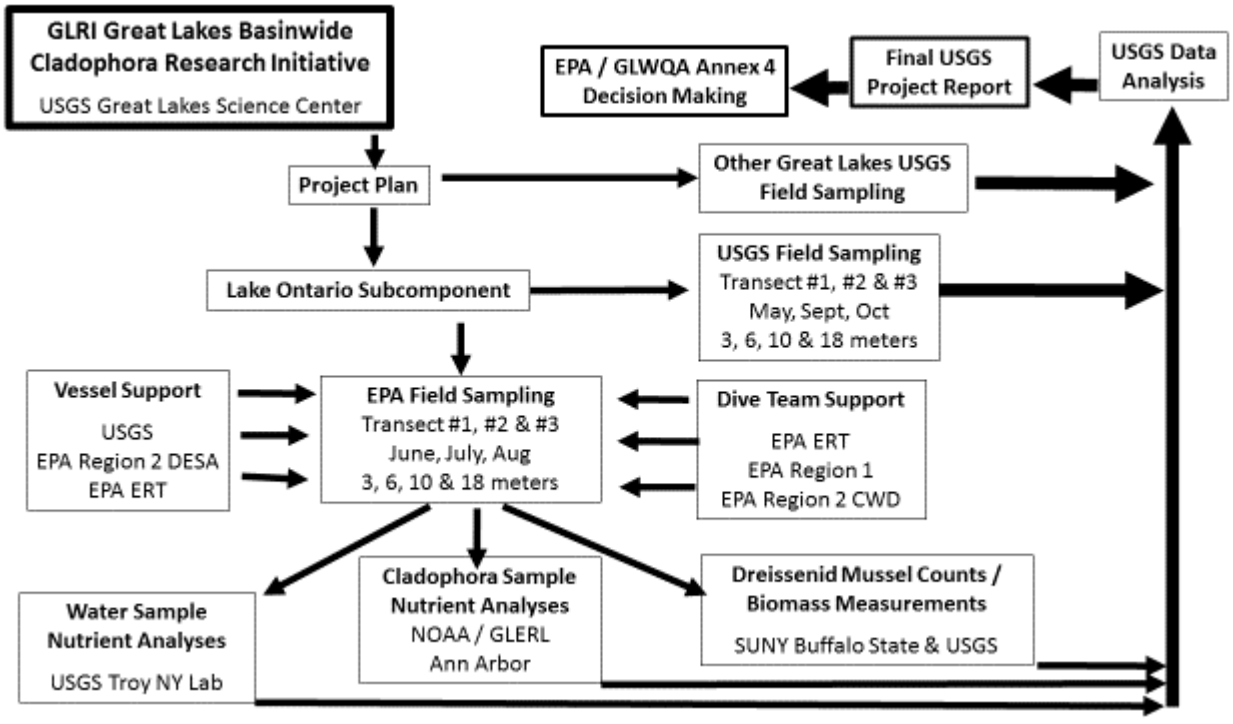


Figure 2 Lake Ontario Diver Benthos Survey Overview

Table 1. Sample Analyses to be performed as part of 2018 Lake Ontario Nearshore Benthos Assessment

				Samples/Transect	Total Samples/Survey	Duplicate Samples	Field Method Blanks	Lab Method Blanks	Bottle Blanks	Field Equipment Blanks	Samples/Season	Total Project Samples
		1 m	Bottom - 0.1 m									
	Total Phosphorus	x	x	8	32	3	6		2	2	45	135
	Total Suspended Solids	x	x	8	32	3	6		2	2	45	135
Unfiltered	Chlorophyll-a	x		4	16	1	3		1		21	63
	Particulate Organic Carbon	x		4	16	1	3		1		21	63
	Particulate Organic Nitrogen	x		4	16	1	3		1		21	63
	Soluble Reactive Phosphorus	x	x	8	32	3	6	1		2	44	132
	Nitrate-Nitrite	x	x	8	32	3	6	1		2	44	132
Field Filtered	Ammonia	x	x	8	32	3	6	1		2	44	132
	Total Kjeldahl Nitrogen	x	x	8	32	3	6	1		2	44	132
	Total Dissolved Phosphorus	x	x	8	32	3	6	1		2	44	132
	Fluoride	x		4	16	1	3	1			21	63
	Chloride	x		4	16	1	3	1			21	63
	Sulphate	x		4	16	1	3	1			21	63
Lab Filtered	Sodium	x		4	16	1	3	1			21	63
	Potassium	x		4	16	1	3	1			21	63
	Silica	x		4	16	1	3	1			21	63
	Dissolved Inorganic Carbon	x		4	16	1	3	1			21	63
	Dissolved Organic Carbon	x		4	16	1	3	1			21	63
Cladophora	Phosphorus & Nitrogen			4	16	2						54

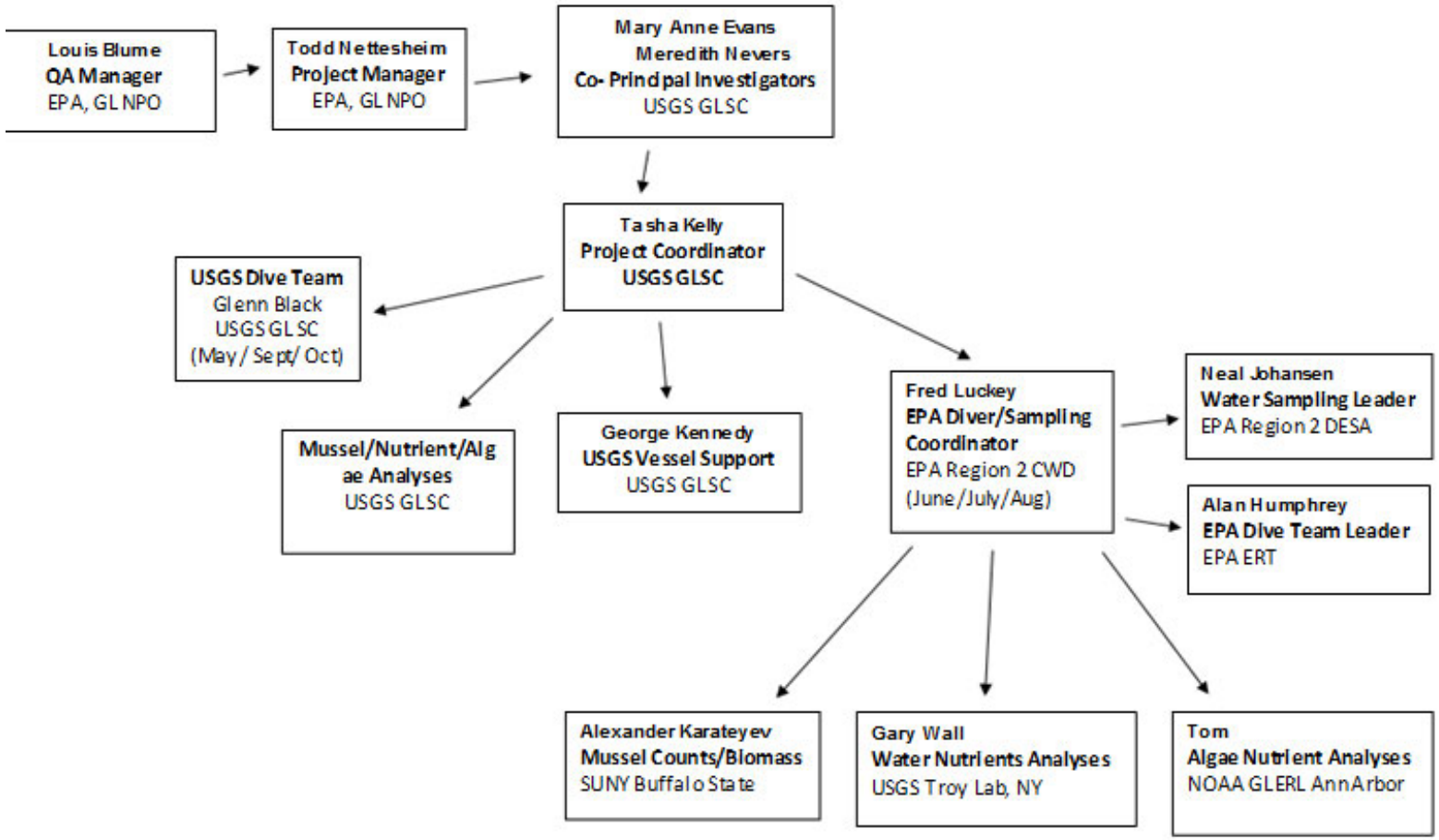


Figure 3 – Lake Ontario Diver Benthos Survey Roles and Responsibilities

Figure 2. Project Overview
Sensor will be deployed for each transect at the 6 m depth station. Sensor deployments will include light, temperature, pH, specific conductivity, dissolved oxygen, turbidity, *in situ* chlorophyll a, *in situ* phycocyanin, and currents. Light sensors to be used include PME miniPAR sensors (1) with miniWIPERs (2) and Onset HOBO Pendant temperature/light loggers as back-ups (3). YSI EXO2 sondes with central wipers (4) and sensors will be used to measure temperature, pH, specific conductivity, dissolved oxygen, turbidity, *in situ* chlorophyll a, and *in situ* phycocyanin. Currents will be measured with Sontek Argonaut-XR 3.0MHZ up-looker ADCPs (5).

More details on the sensors that the USGS dive team will deploy in May 2018 are available at manufacturer's websites:

(1) www.pme.com/products/minipar-logger

(2) www.pme.com/products/miniwiper

(3) www.onsetcomp.com/products/data-loggers/ua-002-64

(4) www.ysi.com/EXO2

(5) www.sontek.com/argonaut-xr

The USGS GLSC will provide the EPA dive team with selected transect station locations and SOPs for how to inspect, maintain and upload data from the moored sensors.

A6. Project/Task Organization:

Mary Ann Evans and Meredith Nevers, USGS Great Lakes Science Center are the Co-PIs for this USGS Great Lakes wide research effort and are responsible for the overall project design, development of SOPs and Quality Assurance Plans.

Todd Nettesheim and Louis Blume, U,S, EPA GLNPO are providing EPA oversight on project plans and quality assurance protocols.

Kashia Kelly, USGS GLSC is providing overall coordination of dive team and analytical laboratory activities.

George Kennedy, USGS GLSC will provide and operate one vessel to support the EPA dive team.

Fred Luckey, EPA Region 2 Project Coordinator: Fred is responsible for coordinating the field sampling efforts and ensuring that sufficient support is available. In consultation with the Principal Investigators, Phil will determine experimental design changes if necessary. He will maintain the official version of the QAPP. Phil will be involved with the data analysis and report/publication preparation.

Alan Humphrey, EPA Region 2 – Unit Dive Officer – Alan is responsible for overseeing and directing all aspects of the diver survey field activities and will ensure that health and safety and sample collection protocols are followed.

Neal Johansen. EPA Region 2, DESA, will collect surficial surface water and samples, conduct YSI water column profiles and process lake bottom water samples collected by divers.

Gary Wall, USGS Troy Office will oversee the analyses of water quality samples

Harvey Vanderplog, NOAA will analyze cladophora samples for phosphorus content

Alexander Karatayev, SUNY Buffalo will analyze the August collection of mussel samples

A7. Quality Objectives and Criteria for Measurement Data:

Quality Criteria have been established for all aspects of this project that involve the generation of data. Some specifics on measurement quality criteria are given in Table 1.

A8. Special Training Requirements/Certifications: This work does require the use of scuba diving for the collection of some of the samples. The project leader is a member of the EPA Region I dive team and has commitments from the other members of the dive team for their participation. All dive operations will be conducted in accordance with normal EPA dive safety protocol. All staff working in the laboratory will have received the required training that includes lab safety training They will also need to demonstrate proficiency with the methods to be performed. We have developed Standard Operating Procedures (SOP) for all of the field sampling in accordance with the Region's Quality Assurance Field Activities Procedures. The Principal Investigators will ensure written copies of the relevant SOPs are on site for reference.

A9. Environmental concerns and mitigation:

A10. Documentation and Records: The Dive Team Leader will ensure that each member of the team will receive an electronic version of the document. In addition, during the time in the field, the Project Leader will have a paper copy of the final approved QAPP on site.

The Dive Team Leader will be responsible for the field log during the field sampling effort. GPS coordinates recorded in the field will be recorded in the field log and also saved electronically on our GPS unit. Upon return to the office, the electronic data will be downloaded to the Project Leader's PC and to a separate location on the Regional EPA LAN and to the USGS PIs.

Field data sheets will be composed of waterproof paper and will be appended to the field log. Upon return to the office, the sheets will be scanned or data entered into an Excel spreadsheet which will be stored on the Project Leader's PC and a secondary location on the Regional LAN.

Neal Johansen will oversee and assist with the generation of all of the laboratory water quality data. He will keep a laboratory notebook and paper data sheets. The data will also be stored electronically at EPA Edison's laboratory. Upon completion of the analysis, copies of the paper data sheets, relevant sections of the laboratory notebook and electronic data file will be transmitted to the Project Leader.

The field log and laboratory notebooks are tools to track sample integrity and record observations that may fall outside of the normal data requirements of the project. During the course of sampling or analysis, the quality of a sample may be compromised due to equipment error, human error or happenstance. The sample identification number, the date, the name of the person providing the

information and a detailed description of how the sample may have been compromised should be recorded in the field log or the laboratory notebook.

This project is scheduled to be a 1 year sampling effort with a final report due to the Region at the end of year 2. This report will contain a summary of the data and will be retained on file indefinitely in case of an audit. The project team also anticipates producing at least 1 peer-reviewed journal article, which could be a lengthy process that will run beyond the 1 year time period. Paper data sheets, lab notebooks and field logs will be retained for 20 years as required by EPA Records Schedule 503. Electronic data files can be retained on the Regional LAN systems indefinitely.

B Measurement/Data Acquisition

TIME FRAME

The field work consists of three (3) three-week surveys, with approximately one week in each survey allocated for work in New York Lake Ontario nearshore areas. The three surveys are intended to permit the establishment of growth curves for the calculation of *Cladophora* growth rates and the monitoring of water quality and benthic condition seasonality. Note that all samples will be kept on ice in the field and delivered at the end of each day to the lab. Initial target dates are:

Survey 1: June 15 – 30, 2018
Survey 2: July 16 – 28, 2018
Survey 3: August 28 – September 8, 2018

It is understood that these time frames may shift one week earlier or later depending on weather conditions and availability of staff and equipment.

Field sampling

Field sampling will be supported by three small vessels to be provided by USGS, EPA DESA and EPA ERT. Vessels will be trailered to public boat launches. Boat launches are a 30 to 40 minute boat ride to the transect locations. The USGS and EPA ERT vessels will support the four man dive team. The EPA DESA vessel will primarily collect and process water samples and perform a water column YSI profile. The dive team leader will determine if weather and wave conditions warrant postponing field sampling.

Survey 1: June 15 – 30, 2018
Survey 2: July 16 – 28, 2018
Survey 3: August 28 – September 8, 2018

It is understood that these time frames may shift one week earlier or later given uncertainties given weather conditions and availability of staff and equipment.

Sequence of Sampling Events

- Launch vessels and locate USGS provided transect/station locations.
- Pre-dive equipment/project safety check.
- Divers collect lake bottom water sample with syringe and deliver it to EPA DESA vessel for sample field filtering, processing and preservation.
- DESA staff collect surficial water sample, prepare syringe sample, measure Secchi depth and conduct YSI profile.
- Divers randomly drop quadrats on cladophora beds within 200' radius of USGS station location.
- Divers photograph or video quadrat locations and measure height of benthic algal mass above lake bottom.
- Divers collect all algae within each quadrat into zip-lock bags.
- Divers collect all mussels within each quadrat into metal pans.
- Divers inspect USGS deployed sensors/cameras and upload data per USGS SOP.
- Prepare, label and preserve all water and biological samples
- Review station checklist and complete diver observation sheets.
- Proceed to next station.

Water Quality Profiles - At all stations, a YSI EXO2 WQ profile will be taken to the bottom at a speed of approximately 10 cm/s to provide information on thermal and chemical depth stratification. The parameters to be logged include depth, temperature, dissolved oxygen, conductivity, chlorophyll a, turbidity and PAR. Data will be provided to study leads at the conclusion of each field survey.

Ensure the probe has been calibrated and tested before taking field measurements, in accordance with this SOP, the project QAPP, and the manufacturer's instructions. Clean the DO probe with DI water before taking measurements. Gently lower the probe into the sample media ensuring that water is all that touches the probe, to prevent any damage to the membrane or probe. Ensure there is sufficient water movement for whichever probe is used. Use of a stirrer mechanism may be required. Read and record the instrument output, DO and temperature, in the field logbook or on data sheets. Remove the probe from the sample media, and rinse the probe with the DI water. Replace any protective cover used with the instrument to prevent any damage.

Secchi Depth Measurement - After completion of the zooplankton tows, a Secchi disk transparency measurement should be taken. Secchi disk transparency measurements should always be taken unless the time is between one hour before sunset and one hour after sunrise or if weather prevents collection. If a sampler is unsure of whether or not to collect a Secchi disk measurement, the sampler should consult with the Chief Scientist. When a Secchi disk reading is not collected, the sampler should indicate the reason (e.g. rough weather or time) on the hard-copy field recording form. When entering the Secchi data into GLENDA, the analyst should enter the reason provided on the hardcopy field recording form into the "comments" field.

The crew will check with the team leader for approval before lowering the secchi disk.

Lower the Secchi disk from the shady side of the boat out of direct sunlight, until it is no longer visible.

Raise the disk slowly until it is just visible again.

Lower the disk once more until it disappears again. Make sure that you cannot see the disk. Secchi depths in the Great Lakes can be quite deep, and as a result, perspective effects can make the disk appear very small and difficult to see.

Keeping your eye on the spot on the rope that was just at the surface of the water as the disk disappeared, raise the rope just enough to grab the rope at that spot, and then tow in the disk.

Measure the length of rope from the disk to the spot you grabbed. This is the Secchi depth. The rope should be marked in meters; estimate the length to the nearest decimeter.

Field duplicates are taken for Secchi disk measurements each time a field duplicate is scheduled for collection for the surface sample of a lake (the sample collected at 1 meter below the surface). If a field duplicate of a surface sample is not scheduled for a given day, at least one field duplicate Secchi disk reading should be conducted at the station sampled closest to noon.. Two different analysts should take the duplicate measurements and the acceptance criteria for these duplicates is less than or equal to 5% of the first measurement + 0.5 meters. Neither technician should know the result obtained by the other technician until the results are recorded. If a duplicate reading fails the acceptance criteria, the two technicians should take another Secchi reading together to determine the cause of the difference.

Collection of Surface Water Quality Samples– At all stations, one 4L water quality sample will be taken from the 1 m depth by directly filling the provided bottle. Each bottle will be labelled with station number, depth of sample (1 m) and date, and samples will be stored in coolers with abundant ice until return to the lab daily. The deck log should be returned with the samples to provide information required for sample submissions.

The Van Dorn sampler is plastic and is lowered in a horizontal position. Set the sampling device so that the sampling end pieces are pulled away from the sampling tube (body) and place in a cocked opened position allowing the substance to be sampled to pass through this tube. Lower the preset sampling device to the predetermined depth. Avoid bottom disturbance. Once at the required depth, a messenger is sent down a rope to cause the stoppers to close the cylinder. Retrieve the sampler and discharge from the bottom drain the first 10 to 20 ml to clear any potential contamination of the valve. Transfer the sample to the appropriate sample container. With a rubber tube attached to the valve, dissolved oxygen sample bottles (BOD bottles) can be properly filled by allowing an overflow of the water being collected. Insert rubber tube into the bottom of the bottle, fill bottle to overflowing for approximately 10 seconds, preventing turbulence and formation of bubbles while filling. When filling other bottles, care should be taken not to make contact between the sampling device and the bottle.

Collection of Near-bottom Water Quality Samples - At all stations, divers will collect 2L of water 0.1 m above the lake bottom using the slurp guns, taking great care not to disturb the area. Slurp guns will be fully rinsed twice, using surface water at the station, prior to taking the samples. Sample bottles will be rinsed twice with a small aliquot of the sample water before filling. Each bottle will be labelled with station number, depth of sample (1 m) and date, and samples will be stored in

coolers with abundant ice until return to the lab daily. The deck log should be returned with the samples to provide information required for sample submissions.

Field Filtering Nutrient Samples – From all surficial and bottom samples), approximately 400 mL will be poured into a handling vessel (after twice rinsing) and the following samples will be filtered in the field using the provided disposable syringes and syringe filters. Note that a new syringe and filter is used at each station. Multiple filters may be required if the sample is very turbid. The syringe will be twice rinsed with sample water, and each bottle will be twice rinsed with an aliquot of syringe-filtered water before filling the following:

a. One 120 mL Boston round glass bottle will be filled with filtered water for soluble nutrients: Soluble Reactive Phosphorus Phosphate, Nitrate + Nitrite, Ammonia and Total Kjeldahl Nitrogen, Dissolved Nitrogen.

b. One French square bottle will be filled with filtered water for Total Dissolved Phosphorus (note*: to be acidified the following day prior to submission)

Lab-Filtered Samples – Samples will be kept on ice in the field and returned daily to the lab with the deck logs. Remaining sample water will be processed for:

Core parameters (both 1m and B-0.1m):
a. Total phosphorus
b. Total suspended solids

Additional WQ parameters (at 1m only):

c. Anions(filtered): Fluoride, chloride and sulphate

d. Cations (filtered): Calcium, magnesium, sodium, potassium, silica

e. Dissolved inorganic carbon and dissolved organic carbon (filtered)

f. Chlorophyll a

g. Particulate organic carbon and particulate organic nitrogen

7. Habitat assessment - the diver will describe the benthic habitat of the general area, recording these on the provided field forms, including but not limited to the following points:

a. Percent cover of various substrate types (e.g., rock, boulders, cobbles, gravel, pebbles, sand, silt, clay),

b. The extent of coverage of live dreissenid mussels, dead mussels, cladophora, other algae, periphyton, debris, organic sediment and the height range of the algae. If the area is covered with soft sediment, the diver will brush away the sediment to determine the underlying substrate and the depth of sediment.

c. The abundance of gobies observed in the area will be quantified (the number visually estimated, or described as abundant, etc.).

Upon conclusion of each field survey, the completed field forms will be returned to the study leaders.

8. **Quadrats** – the diver will place 0.15 m_2 quadrats randomly on the substrate at the study area. A total of **three (3)** quadrats will be sampled at each station. All observations and information about samples collected will be recorded on the provided field forms (one form per station) that were also used for item 7 (habitat assessment).

9. **Quadrat habitat assessment** – the diver will photograph and describe the benthic habitat of each individual quadrat, covering the same points as indicated for item 7. In some cases, it may be necessary to first conduct the cladophora and mussel collections (items 10 and 11, below) before being able to assess the underlying substrate conditions. Observations will be recorded on the field form at each station.

10. **Cladophora harvesting** – the diver will collect by hand all *Cladophora* from each quadrat, taking care to place it into the mesh bag lowered for this purpose. On deck, the samples will be transferred to Whirl-paks, drained of water as much as possible and stored in coolers with ice. Bags should be labelled with the station number, date, and quadrat number (1 of 3, etc.) and all samples are to be recorded on the deck log. Samples will be kept on ice, but NOT frozen, until return to the lab where they will be delivered at the end of each day.

Attachment B: *Cladophora* Weight Measurement Methods

Materials/Supplies:
Newspaper
Paper Towels (Heavy Duty)
Plastic Gloves (if possible, surgical gloves)
Tweezers
Plastic Bags/Trash Bags/Ziploc Bags
Two Official USPS 10-lb Postal Scales (0.1 oz-accuracy)
Spray Cleaner (e.g. Lysol or Bleach)
Camera
Dry Erase Board or some sort of flat, white surface
Ice (if storing *Cladophora*)
Sharpies/Pens
Optional: Face Mask

Tasks:

1. Take photos of Cladophora sample with mussels attached. Use a dry erase board or flat, white surface as a background (also holds the excess water). Wipe surface after every sample. After every sample is photographed, make sure to clean everything up (spray surfaces down).

2. Remove mussels from samples; return shells to sample bag in case they are needed. Use tweezers in case the *Cladophora* is stuck to the mussels. Try to detach mussels from *Cladophora* before it starts to decompose. Otherwise the mussels become brittle and decompose into a runny substance. With our requirements to keep *Cladophora*, on ice, or frozen, this should not occur (see data quality instructions in the Quality Assurance Performance Plan)
For the mussels that are removed, along with other trash (wet paper towels/newspaper), place them in a trash bag that is double bagged if the mussels will not be used again. Make sure to take this bag out to the dumpster. Do not leave it in the office. It will start to smell.

3. Weigh wet Cladophora samples. Make sure to write the weight down. When weighing the sample, squeeze excess water before you weigh it. Make sure to not place it back in sample bag after weighing. Otherwise it will absorb more water and take longer to dry. Form the sample into a dense ball so that it can fit on the scale. Weight each sample three times on each of the two official USPS postal scales. If weights differ by more than 0.1 oz when measured on each scale, see data quality instructions on obtaining a new scale.

4. Place *Cladophora* samples out to dry (will take up to a week for the samples to completely dry). Make sure to have a lot of paper towels and newspaper. The *Cladophora* will be placed on both when drying and the mats can hold a lot of water. A good method to use is to layer the newspaper (about 4 sheets thick) with some paper towel in between each newspaper layer. Remember to change out both the paper towels and newspaper daily, since the paper will be waterlogged. This will speed up the drying process and get rid of the smells.
When spreading out the *Cladophora* to dry, try not to rip it into pieces. Small hairs will become detached and they are really hard to pick up. Also, it is easier to mix up samples this way. Flip the sample over so that both sides can dry.
Draw boundaries for each sample. You do not want samples to get mixed together. Make sure to clearly label each area. Use a permanent marker (Sharpie) so the ink does not run as easily if water happens to get on it.

5. Weigh dried *Cladophora* samples. Compare with wet weight. The postage scales used in this study cannot register weights below 0.1 ounces. They will appear as 0.0 oz. List as “trace” in the data table if this occurs.

6. After weighing the dried samples, do not throw them away. They will be collected and archived in Ziploc bags for further potential study.

11. **Dresseinid harvesting** – Divers will photograph each quadrat and collect all the dresseinid mussels from the quadrat by hand or airlift, using a scraper if necessary to facilitate collection from hard surfaces, and only to the depth necessary to collect the live mussels (approximately 5 cm), taking care to place them into the provided mesh bag. On deck, the samples will be washed of debris, and transferred into the provided storage containers (lidded aluminium trays). Any clumps of cladophora retrieved with the mussels should be transferred to the corresponding quadrat’s whirlpak. The storage containers should be drained of water as much as possible and labelled with the station number, depth of station, date and quadrat number (Q1, Q2 or Q3). All samples are to be recorded on the deck log. If more than one container is used, this should be recorded on both the deck log and the containers (e.g., 1 of 2). Samples will be kept on ice until returned to the lab where they will be refrigerated. They will be subsequently drained, inventoried and placed in the freezer.

12. **Bulk Cladophora for nutrients** – At all stations, divers will collect sufficient (enough for 1 small ziplock freezer bag) *Cladophora* from an area outside the quadrats for the purposes of nutrient analysis of the algae. On deck, the samples will be transferred to a Whirl-pak or Ziplock bag, drained of water as much as possible and stored in a

cooler with ice. Bags should be labelled with the station number, depth of station, date and identified as the "bulk" sample. It is recognized that at certain stations or certain times, collection of large amounts of material is unlikely.

13. **Other algae sampling** – at stations where other algae is observed, a sample will be taken into a sample jar, bag or other suitable container for latter identification. Samples will be fixed with Lugol's on board and stored in a cooler until return to the lab.

DATA QUALITY ASSURANCE

14. **Duplicate samples** will be collected at every tenth station at both the surface and bottom depths (i.e., both items 3 and 4) and will be processed for all field filtered and lab filtered parameters (i.e., items 5 and 6), as appropriate. Duplicate samples must be clearly labelled on deck logs, sample labels and submission forms.

15. **Method blanks (in the field)** will be performed at three stations per week for each bottle in item 5. Using a fresh syringe and filter, use the provided MilliQ water as if it were a sample. Method blanks should be identified on the deck logs, sample labels and submission forms.

16. **Method blanks (in the lab)** will be performed at a rate of one blank per 40 samples for each bottle in item 6 by filtering MilliQ water through the appropriate filter and filling bottles (after twice rinsing). Method blanks should be identified on submission forms.

17. **Bottle blanks (in the lab)** will be performed at a rate of 1 blank per 20 samples for each unfiltered water quality parameter (i.e., TP). The bottles are twice rinsed and then filled with blank water and submitted as samples. Bottle blanks will be identified on the sample labels and on submission forms.

18. **Field equipment blanks (in the lab)** will be run at the end of each campaign by twice rinsing the slurp gun(s) used in the field with MilliQ water, filling the gun again with MilliQ water and then processing the water for all parameters in items 5 and 6. One equipment blank will be processed for each slurp gun used, at the end of each survey. These samples will be identified as field equipment blanks on the sample labels and submission forms.

19. **Cladophora extent** - if abundant cladophora is observed at deepest stations of each transect, observations should be made out to the 30 m depth to document the extent of Cladophora growth in the region.

B3. Sample Handling and Custody Requirements

The sample handling and storage methods for these samples are listed in Table 2. Chain of custody procedures are not required for this project.

B4. Analytical Methods

Sample preparation and Analysis

B5. Quality control

Table 3 lists the quality control checks that are conducted for each of the instruments utilized. The quality control criteria used to evaluate the performance of the instruments is listed in Tables 3.

B6. Instrument/Equipment Testing, Inspection and Maintenance Requirements

The inspection and maintenance conducted on the instrumentation is listed in Table 4.

B7. Instrument Calibration and Frequency

GPS signal quality will be confirmed prior to starting the survey by checking the relevant settings. Verification of data collection will be continuous during the survey. In the event of a data recording loss, as indicated by an error code on the instrument, there will be additional attempts to recapture coordinates. Frequently, we will have multiple GPS units available, so if one fails we will have a backup.

HOBO sensors come pre-calibrated. Data collection starts prior to deployment and does not end until the sensor is stopped during the data downloading process. The full data record will be reviewed and data prior to deployment and post recovery will be discarded.

B8. Inspection/Acceptance Requirements for Supplies and consumables

Consumables required for this project include materials for sample collection, such as Ziploc bags and supplies for field filtering water samples and containers for collected mussels.

B9. Data Acquisition Requirements (Non-direct Measurements)

We are generating all of the data for the project. If we find existing data that can be used, this QAPP will be modified to identify how that data will be handled.

B10. Data Management

Measures intended for use in subsequent manipulations and analyses (hereafter referred to as primary data) will be transcribed to electronic spread sheets (typically Excel) created and manipulated on personal computers. Records will be maintained of file names and contents. As appropriate, hard copies will be generated for storage in activity files kept by the Principal Investigators.

Whenever possible, transfer between data files and product files will be performed electronically to minimize errors of transcription. Written observations will recorded electronically by the Project Leader and double checked by at least one of the PIs. Standard commercial software packages (PowerPoint, Excel, WordPerfect, Word, etc.) will be used to develop graphical and tabular data presentations. As appropriate, hard copies of products with associated presentations of data will be generated for storage in activity files kept by the Principal Investigators.

Electronic copies of all computer files will be stored on Region I and 2's network servers. All data manipulations will occur using the copy resident on the PC hard drive, with copies made to the servers. Hard copies of electronic data files will be obtained at the end of the study for archival purposes.

C. Assessment/Oversight

C1. Assessments and Response Actions

A number of assessment procedures will be implemented to ensure the quality of project products. These include:

1.- Record keeping and data entry – All data entered into laboratory notebooks and data sheets will be double checked for accuracy by the recorder and a second individual. Similarly, data entered into computerized spread sheets will be double checked for transcription errors by the person entering the data.

2.- Statistical procedures –

3.- Internal and external peer review of manuscripts, presentations, and reports – Final Report and manuscript prepared for publication will be reviewed by the project team. In addition, we will follow the Region's Peer Review policy and have at least 2 additional reviewers that are not on the project team. Prior to submittal for publication to a peer-reviewed journal, the Office of Public Affairs will review the manuscript.

C2. Reports to Management

Annual verbal reports on the progress of this research will be provided to management and to the Regional Science Counsel.

D. Data Validation and Usability

D1. Data Review, Verification, and Validation

The criteria used to validate data generated as part of this project are listed in Table 1. The Project Leader will perform the data manipulation with verification provided by one or more of the PI's on the project.

D2. Verification and Validation Methods

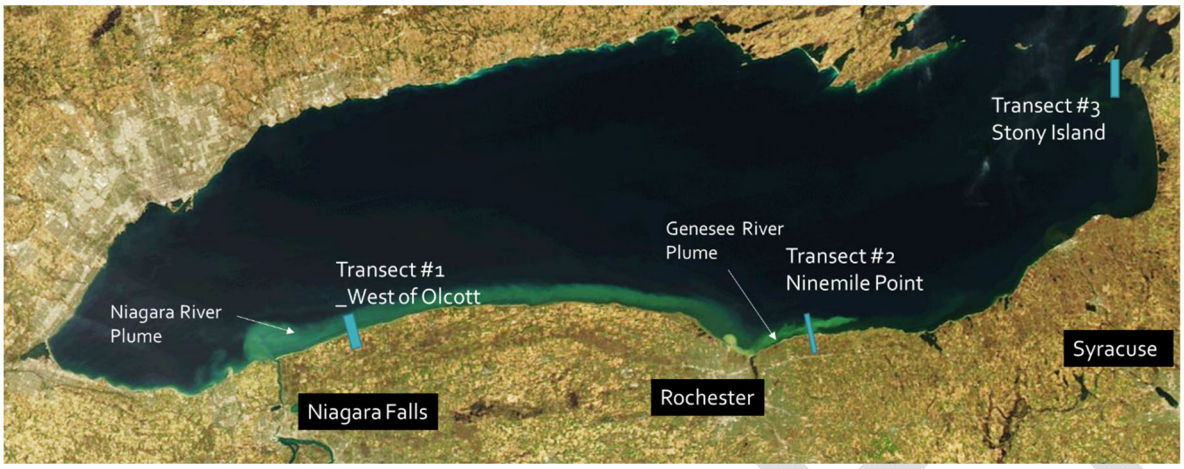
In addition to these criteria listed in Table 1 we also assess data sets for outliers. Outliers will be defined as data points that may be 2 times the standard deviation from the mean of the dataset. If outliers are identified samples may be re-analyzed if they are still available.

D3. Reconciliation with User Requirements

The results from this research will be incorporated into a written report. Comments will also be requested on any reports and all comments will be addressed in the final reports. In addition, oral presentations will be made as part of Great Lakes Water Quality Agreement Nutrient Annex 4 Sub-committee meetings. In both the written report and during the presentation, any limitations on the data or the conclusions will be clearly articulated.

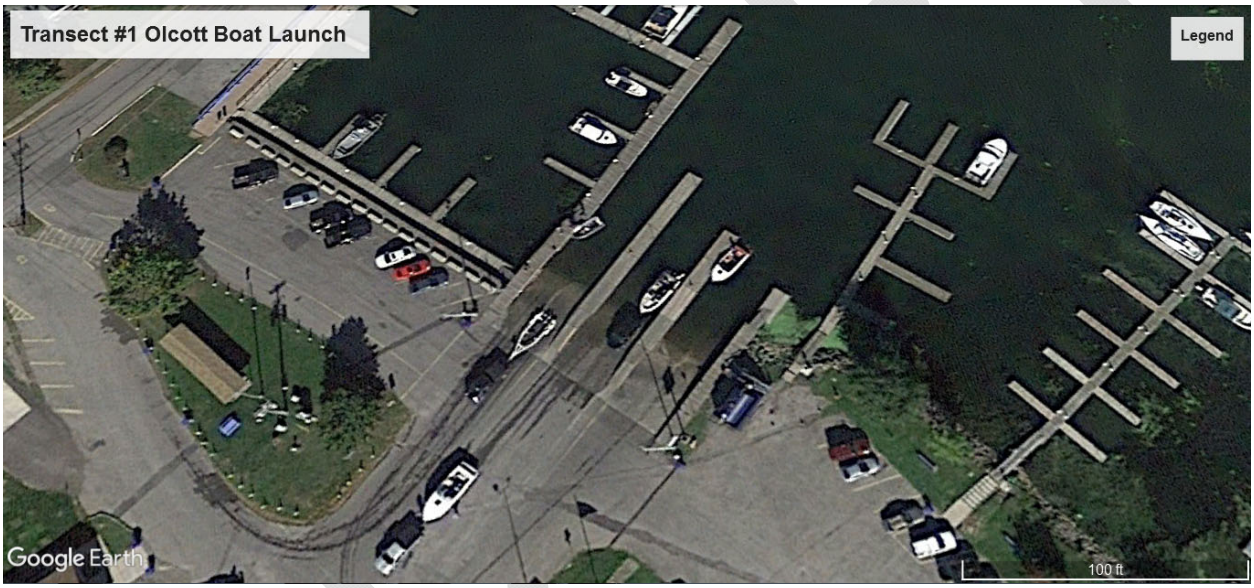
ATTACHMENT 1

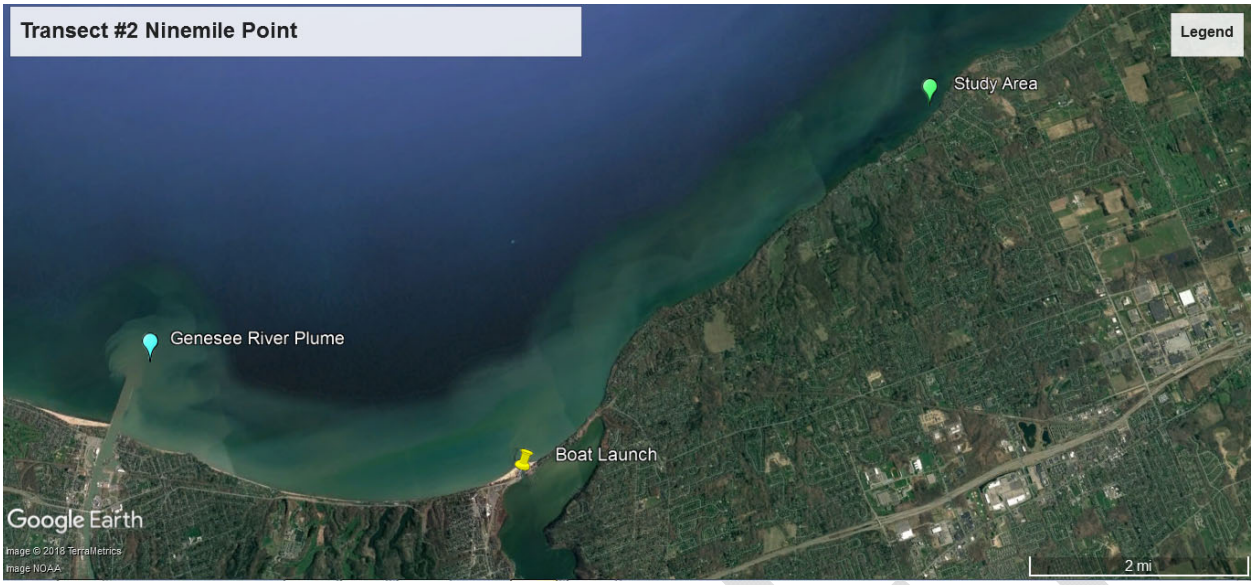
Proposed Lake Ontario New York Diver Benthos Survey Transect Locations



	Boat Launch Location	Transect Distance From Boat Launch	Distance Offshore to 30 m depth	Drive Time to next transect
Transect #1 - West of Olcott	Olcott	2.5 miles	~ 1.25 miles	~ 2 hours
Transect #2 - Ninemile Point	Irondequoit Bay	5.5 miles	~1.25 miles	~3 hours
Transect #3 - Stony Island	Henderson Harbor	10 miles	~ 1 mile	


Transect #1 West of Olcott
Legend
Olcott Marina
Study Area
Google Earth
Image © 2018 TerraMetrics
Image NOAA
5000 ft


Transect #1 Olcott Boat Launch
Legend
Google Earth
100 ft


Transect #2 Ninemile Point
Legend
Study Area
Genesee River Plume
Boat Launch
Google Earth
Image © 2016 TerraMetrics
Image NOAA
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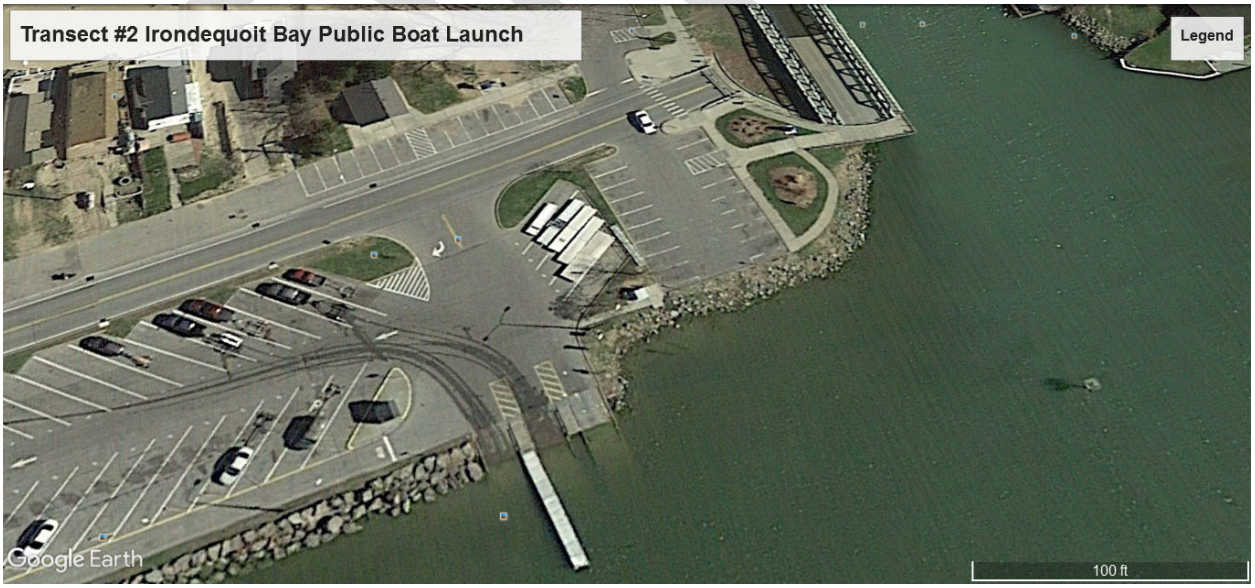
Transect #2 Irondequoit Bay Public Boat Launch
Legend
Google Earth
100 ft

Transect #3 – Stony Island

ATTACHMENT 2

2018 Lake Ontario New York Diver Survey

Station Location: _____ ***Depth:*** _____***Date:*** _____

A. Station Observations :

Surficial Substrate % Composition:

Silt _____ Clay _____ Sand _____ Gravel _____ Cobble _____ Rock _____ Bedrock _____

Boulders _____ Shale _____ Underlying Substrate Type: _____ Underlying Substrate Depth: _____

General Description of Surface:

_____

_____

_____

Benthic Algae/Dreissenid Mussel % Composition and Thickness:

Cladophora *Overall* Coverage (Qualitative) (%): _____

Cladophora Distribution over Bottom General Comments (e.g. variability, colour, density, health):

_____

_____

Dreissenid Mussel Composition and Collections

Zebra/Quagga Mussel *Overall* Bottom Coverage (Qualitative) (%): _____

Zebra/Quagga Mussel Distribution over Bottom General Comments:

_____

_____

B. Quadrat Observations :

Quadrat 1: Live Mussels (%): _____ Empty Mussel Shells (%)**:**_____

% Cladophora _____ Height (cm) _____ Range (cm) _____

Quadrat 2: Live Mussels (%): _____ Empty Mussel Shells (%)**:**_____

% Cladophora _____ Height (cm) _____ Range (cm) _____

Quadrat 3: Live Mussels (%): _____ Empty Mussel Shells (%)**:**_____

% Cladophora _____ Height (cm) _____ Range (cm) _____

C. Collections:

a. Algae

Cladophora Collected from 0.15 m^2 Quadrats (Y/N) 1 _____ 2_____ 3_____

Samples of *Cladophora* Filaments for Nutrient Analysis(Y/N) 1_____

Qualitative Sample of other algae if abundant (Y/N) 1_____

b. Mussels

Mussels Collected from 0.15 m^2 Quadrats (Y/N) 1 _____ 2_____ 3_____

D. Gobies:

Goby Relative Abundance: Sparse Moderate Abundant

Goby Description (where observed):

_____

Gobies Size Range (cm):_____

Additional Comments:

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